A METHOD FOR ION FOCUSING OF AN ELECTRON STREAM IN A HIGH VACUUM

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FIRST LINE OF TEXT

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The defocusing effect of a negative space charge of electrons in a low vacuum is eliminated by the creation of a concentration of positive ions in any cross section of the electron beam equal to the concentration of electrons in that cross section. If the residual gas pressure in the space is 10^{-8} or higher, the necessary ion concentration is easily attained independent of the degree of ion leakage from the electron-beam space. In a high vacuum, in order to attain equality of electron and ion concentrations it is necessary to create in the beam space a definite potential distribution, decreasing the escape of ions from the beam.

According to the method being described, it is proposed that the electron beam passed in a moderating (decelerating) field. Such a field occurs, for example, when the beam moves from a accelerating diaphragm to a collector whose positive potential is less than the potential of the diaphragm. In this case the ions move in the same direction as the electrons, i.e., toward the collector.

As they approach the collector, the electron velocity decreases, while the ion velocity increases. Therefore, the relative axial velocity decreases. Owing to the decrease in axial velocity of electrons, their density per unit length of the beam increases. On the other hand, the probability of ionization of molecules of the residual gases increases as the magnitude of the axial potential and, as is known, has a maximum when the potential V = 100 v for nitrogen.

For these reasons, at a definite axial potential gradient, complete neutralization of a negative charge can occur in each cross section of the beam.

At an optimum beam injection angle in to a space having a moderating field, it is possible to obtain a beam of cylindrical shape.

Thus at a definite decelerating-field gradient, focusing takes place in the absence of the focusing devices usually used (as a rule, electromagnetic devices).

Owing to the fact that there is for all practical purposes no departure of positive ions from the collector-diaphragm space to the cathode in moderating fields, the operating life of the cathode is increased. In addition, collector heating is reduced.

The use of the proposed method of focusing in resistance-retarding type amplifiers eliminates the necessity, in complex and large devices, of creating a magnetic field which increases in strength along the axis of the beam in inverse proportion to the electron velocity. This is especially essential in millimeter-wave amplifiers, where strong magnetic fields are required.

Object of the Invention

The method of ion focusing of an electron beam in a high vacuum differs in that, in order to simplify the electron-optical system, reduce bombarding of the cathode by positive ions and to ensure low heating of the collector, the electron stream is passed in a decelerating electrostatic field; the field gradient is chosen such that the negative space charge is compensated in each cross section of the stream.

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